
SCIENCE AND TECHNOLOGY

Science and technology provide people with the knowledge and tools to understand and appreciate the natural and designed worlds and address many of the challenges. Students must be provided with opportunities to access, understand, and evaluate current information and tools related to science and technology if they are to be ready to live in a 21st century global society.

The study of science and technology includes both processes and bodies of knowledge. Scientific processes are the ways scientists investigate and communicate about the natural world. The scientific body of knowledge includes concepts, principles, facts, laws, and theories about the way the world around us works. Technology includes the technological design process and the body of knowledge related to the study of tools and the effect of technology on society.

Science and technology merge in the pursuit of knowledge and solutions to problems that require the application of scientific understanding and product design. Solving technological problems demands scientific knowledge while modern technologies make it possible to discover new scientific knowledge. In a world shaped by science and technology, it is important for students to learn how science and technology connect with the demands of society and the knowledge of all content areas. It is equally important that students are provided with learning experiences that integrate tools, knowledge, and processes of science and technology.

The Science and Technology Standards outline the essential understandings of these disciplines. Standard A describes four themes that serve as a broad scaffold for understanding and organizing student understanding of the content and processes of science and technology. Standard B describes the processes of scientific inquiry and technological design. As a complement to the expectations of inquiry and design outlined in Standard B, Standard C describes the enterprises of science and technology and the connection to society. Standards D and E have performance indicators that encompass the subject matter conventionally referred to as life, physical, and earth and space science. It is essential that classroom instruction integrate the processes and ideas of Standards A, B, and C with the knowledge of Standards D and E, rather than teach them separately. Instruction should support students in asking questions and making inquiries to help them, understand and solve problems that require the integration of knowledge and processes in authentic contexts.

Unifying Themes - The proposed revised standards begin with a focus on four themes of science and technology: systems, models, and constancy and change, and scale. These themes provide teachers and students with a scaffold on which to organize the details of the standards. National standards documents identify these themes as critical knowledge for students in the 21st century.

The Skills of Scientific Inquiry and Technological Design Process - The Science and Technology Standards define both the student skills of scientific inquiry and the student skills of technological design. The inclusion of scientific inquiry, the development of a coherent section on technological design and the inclusion of a standard on scientific and technological enterprise highlight the importance of developing student understanding of the unique characteristics of and relationships between science and technology. The scientific and technological enterprise standard outlines key understandings about

the relationships among science, technology and society and underscores the role of citizens in the decision-making process related to science and technology.

OUTLINE OF SCIENCE AND TECHNOLOGY STANDARDS AND PERFORMANCE INDICATOR LABELS

A. Unifying Themes

1. Systems
2. Models
3. Constancy and Change
4. Scale

B. The Skills and Traits of Scientific Inquiry and Technological Design

1. Skills and Traits of Scientific Inquiry
2. Skills and Traits of Technological Design

C. The Scientific and Technological Enterprise

1. Understandings of Inquiry
2. Understandings about Science and Technology
3. Science, Technology, and Society
4. History and Nature of Science

D. The Physical Setting

1. Universe and Solar System
2. Earth
3. Matter and Energy
4. Force and Motion

E. The Living Environment

1. Biodiversity
2. Ecosystems
3. Cells
4. Heredity and Reproduction
5. Evolution

A. Unifying Themes: Students apply the principles of *systems*, *models*, constancy and change, and scale in science and technology.

A1 Systems

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
<p>Students recognize that parts work together, and make up whole man-made and natural objects.</p> <p>a. Explain that most man-made and natural objects are made of parts.</p> <p>b. Explain that when put together, parts can do things they could not do separately.</p>	<p>Students explain interactions between parts that make up whole man-made and natural things.</p> <p>a. Give examples that show how individual parts of organisms, ecosystems, or man-made structures can influence one another.</p> <p>b. Explain ways that things including organisms, ecosystems, or man-made structures may not work as well (or at all) if a part is missing, broken, worn out, mismatched, or misconnected.</p>	<p>Students describe and apply principles of <i>systems</i> in man-made things, natural things, and processes.</p> <p>a. Explain how individual parts working together in a <i>system</i> (including organisms, Earth systems, solar systems, or man-made structures) can do more than each part individually.</p> <p>b. Explain how the output of one part of a <i>system</i>, including waste products from manufacturing or organisms, can become the input of another part of a <i>system</i>.</p> <p>c. Describe how <i>systems</i> are nested and that <i>systems</i> may be thought of as containing subsystems (as well as being a subsystem of a larger <i>system</i>) and apply the understanding to analyze <i>systems</i>.</p>	<p>Students apply an understanding of <i>systems</i> to explain and analyze man-made and natural phenomena.</p> <p>a. Analyze a <i>system</i> using the principles of boundaries, subsystems, inputs, outputs, feedback, or the <i>system's</i> relation to other <i>systems</i> and design solutions to a <i>system</i> problem.</p> <p>b. Explain and provide examples that illustrate how it may not always be possible to predict the impact of changing some part of a man-made or natural <i>system</i>.</p>

A2 Models

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
<p>Students identify <i>models</i> and the objects they represent to learn about their features.</p> <p>a. Describe ways in which toys and pictures are like the real things they model.</p> <p>b. Use a <i>model</i> as a tool to describe the motion of objects or the features of plants and animals.</p>	<p>Students use <i>models</i> to represent objects, processes, and events from the physical setting, the living environment, and the technological world.</p> <p>a. Represent the features of a real object, event, or process using <i>models</i> including geometric figures, number sequences, graphs, diagrams, sketches, maps, or three-dimensional figures and note ways in which those representations do (and do not) match features of the originals.</p>	<p>Students use <i>models</i> to examine a variety of real-world phenomena from the physical setting, the living environment, and the technological world and compare advantages and disadvantages of various <i>models</i>.</p> <p>a. Compare different types of <i>models</i> that can be used to represent the same thing (including <i>models</i> of chemical reactions, motion, or cells) in order to match the purpose and complexity of a model to its use.</p> <p>b. Propose changes to <i>models</i> and explain how those changes may better reflect the real thing.</p>	<p>Students evaluate the effectiveness of a <i>model</i> by comparing its predictions to actual observations from the physical setting, the living environment, and the technological world.</p>

A3 Constancy and Change

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
<p>Students observe that in the physical setting, the living environment, and the technological world some things change over time and some things stay the same.</p> <p>a. Describe the size, weight, color, or</p>	<p>Students identify and represent basic patterns of change in the physical setting, the living environment, and the technological world.</p> <p>a. Recognize patterns of change including steady, repetitive,</p>	<p>Students describe how patterns of change vary in physical, biological, and technological <i>systems</i>.</p> <p>a. Describe <i>systems</i> that are changing including ecosystems, Earth <i>systems</i>, and technologies.</p> <p>b. Give examples of <i>systems</i></p>	<p>Students identify and analyze examples of constancy and change that result from varying types and rates of change in physical, biological, and technological <i>systems</i> with and without <i>counterbalances</i>.</p>

LEARNING RESULTS: PARAMETERS FOR ESSENTIAL INSTRUCTION

2007

Highlighted = Maine Department of Education Regulation 131Words in *blue italics* are defined in the glossary.

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
movement of things over varying lengths of time and note qualities that change or remain the same.	irregular, or apparently unpredictable change. b. Make tables or graphs to represent changes.	including ecosystems, Earth systems, and technologies that appear to be unchanging (even though things may be changing within the <i>system</i>) and identify any feedback mechanisms that may be modifying the changes. c. Describe rates of change and cyclic patterns using appropriate grade-level mathematics.	

A4 Scale

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
Students observe differences in scale. a. Compare significantly different sizes, weights, ages, and speeds of objects.	Students use mathematics to describe scale for man-made and natural things. a. Measure things to compare sizes, speeds, times, distances, and weights. b. Use fractions and multiples to make comparisons of scale.	Students use scale to describe objects, phenomena, or processes related to Earth, space, matter, and mechanical and living <i>systems</i> . a. Describe how some things change or work differently at different scales. b. Use proportions, averages, and ranges to describe small and large extremes of scale.	Students apply understanding of scale to explain phenomena in physical, biological, and technological <i>systems</i> . a. Describe how large changes of scale may change how physical and biological <i>systems</i> work and provide examples. b. Mathematically represent large magnitudes of scale.

- B. The Skills and Traits of Scientific Inquiry and *Technological Design*: Students plan, conduct, analyze data from and communicate results of in-depth scientific investigations; and they use a systematic process, tools, equipment, and a variety of materials to create a *technological design* and produce a solution or product to meet a specified need.

B1 Skills and Traits of Scientific Inquiry

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
<p>Students conduct and communicate results of simple investigations.</p> <ul style="list-style-type: none"> a. Ask questions and make observations about objects, organisms, and events in the environment. b. Safely conduct simple investigations to answer questions. c. Use simple instruments with basic units of measurement to gather data and extend the senses. d. Know what constitutes evidence that can be used to construct a reasonable explanation. e. Use writing, speaking, and drawing to communicate investigations and explanations. 	<p>Students plan, conduct, analyze data from, and communicate results of investigations, including <i>fair tests</i>.</p> <ul style="list-style-type: none"> a. Pose investigable questions and seek answers from reliable sources of scientific information and from their own investigations. b. Plan and safely conduct investigations including simple experiments that involve a <i>fair test</i>. c. Use simple equipment, tools, and appropriate metric units of measurement to gather data and extend the senses. d. Use data to construct and support a reasonable explanation. e. Communicate scientific procedures and explanations. 	<p>Students plan, conduct, analyze data from, and communicate results of investigations, including simple experiments.</p> <ul style="list-style-type: none"> a. Identify questions that can be answered through scientific investigations. b. Design and safely conduct scientific investigations including experiments with controlled variables. c. Use appropriate tools, metric units, and techniques to gather, analyze, and interpret data. d. Use mathematics to gather, organize, and present data and structure convincing explanations. e. Use logic, critical reasoning and evidence to develop descriptions, explanations, predictions, and <i>models</i>. f. Communicate, critique, and analyze their own scientific work and the work of other students. 	<p>Students methodically plan, conduct, analyze data from, and communicate results of in-depth scientific investigations, including experiments guided by a testable hypothesis.</p> <ul style="list-style-type: none"> a. Identify questions, concepts, and testable hypotheses that guide scientific investigations. b. Design and safely conduct methodical scientific investigations, including experiments with controls. c. Use statistics to summarize, describe, analyze, and interpret results. d. Formulate and revise scientific investigations and <i>models</i> using logic and evidence. e. Use a variety of tools and technologies to improve investigations and communications. f. Recognize and analyze alternative

LEARNING RESULTS: PARAMETERS FOR ESSENTIAL INSTRUCTION

2007

Highlighted = Maine Department of Education Regulation 131

Words in *blue italics* are defined in the glossary.

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
			<p>explanations and <i>models</i> using scientific criteria.</p> <p>g. Communicate and defend scientific ideas.</p>

B2 Skills and Traits of *Technological Design*

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
<p>Students use a simple design process and basic tools and materials to solve a problem or create a product.</p> <p>a. Describe a design problem in their own words.</p> <p>b. Propose a way to build something or cause something to work better.</p> <p>c. Use suitable tools, materials, safe techniques, and measurements to implement a proposed solution to a design problem.</p> <p>d. Judge how well a product or design solved a problem.</p> <p>e. Present a design or solution to a problem using oral, written, or pictorial means of communication.</p>	<p>Students use a design process, simple tools, and a variety of materials to solve a problem or create a product, recognizing the constraints that need to be considered.</p> <p>a. Identify and explain a simple design problem and a solution related to the problem.</p> <p>b. Propose a solution to a design problem that recognizes constraints including cost, materials, time, space, or safety.</p> <p>c. Use appropriate tools, materials, safe techniques, and quantitative measurements to implement a proposed solution to a design problem.</p> <p>d. Balance simple constraints in carrying out a proposed solution to a design problem.</p>	<p>Students use a systematic process, tools, equipment, and a variety of materials to design and produce a solution or product to meet a specified need, using established criteria.</p> <p>a. Identify appropriate problems for <i>technological design</i>.</p> <p>b. Design a solution or product.</p> <p>c. Communicate a proposed design using drawings and simple <i>models</i>.</p> <p>d. Implement a proposed design.</p> <p>e. Evaluate a completed design or product.</p> <p>f. Suggest improvements for their own and others' designs and try out proposed modifications.</p> <p>g. Explain the design process including the stages of problem identification, solution design,</p>	<p>Students use a systematic process, tools and techniques, and a variety of materials to design and produce a solution or product that meets new needs or improves existing designs.</p> <p>a. Identify new problems or a current design in need of improvement.</p> <p>b. Generate alternative design solutions.</p> <p>c. Select the design that best meets established criteria.</p> <p>d. Use <i>models</i> and simulations as prototypes in the design planning process.</p> <p>e. Implement the proposed design solution.</p> <p>f. Evaluate the solution to a design problem and the consequences of that solution.</p> <p>g. Present the problem, design</p>

LEARNING RESULTS: PARAMETERS FOR ESSENTIAL INSTRUCTION

2007

Highlighted = Maine Department of Education Regulation 131

Words in *blue italics* are defined in the glossary.

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
	e. Evaluate their own design results, as well as those of others, using established criteria. f. Modify designs based on results of evaluations. g. Present the design problem, process, and design or solution using oral, written, and/or pictorial means of communication.	implementation, and evaluation.	process, and solution to a design problem including models, diagrams, and demonstrations.

C. The Scientific and Technological Enterprise: Students understand the history and nature of scientific knowledge and technology, the processes of inquiry and *technological design*, and the impacts science and technology have on society and the environment.

C1 Understandings of Inquiry

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
Students describe the use of questions and accurate communication in scientists' work. a. Describe how scientific investigations involve asking and answering a question. b. Point out the importance of describing things and investigations accurately so others can learn about them or repeat them.	Students describe how scientific investigations result in explanations that are communicated to other scientists. a. Describe how scientists answer questions by developing explanations based on observations, evidence, and knowledge of the natural world. b. Describe how scientists make their explanations public.	Students describe how scientists use varied and systematic approaches to investigations that may lead to further investigations. a. Explain how the type of question informs the type of investigation. b. Explain why it is important to identify and control variables and replicate trials in experiments. c. Describe how scientists' analyses of findings can lead to new investigations.	Students describe key aspects of scientific investigations: that they are guided by <i>scientific principles</i> and knowledge, that they are performed to test ideas, and that they are communicated and defended publicly. a. Describe how hypotheses and past and present knowledge guide and influence scientific investigations. b. Describe how scientists defend their evidence and explanations

LEARNING RESULTS: PARAMETERS FOR ESSENTIAL INSTRUCTION

2007

Highlighted = Maine Department of Education Regulation 131

Words in *blue italics* are defined in the glossary.

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
			using logical arguments and verifiable results.

C2 Understandings About Science and Technology

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
<p>Students recognize that people have always engaged in science and technology and that there is a difference between the natural and designed worlds.</p> <p>a. Recognize that people have always had problems and invented tools and ways of doing things to solve problems.</p> <p>b. Distinguish between objects that occur in nature and objects that are man-made.</p>	<p>Students describe why people use science and technology and how scientists and engineers work.</p> <p>a. Describe how scientists seek to answer questions and explain the natural world.</p> <p>b. Describe how engineers seek solutions to problems through the design and production of products.</p>	<p>Students understand and compare the similarities and differences between scientific inquiry and <i>technological design</i>.</p> <p>a. Compare the process of scientific inquiry to the process of <i>technological design</i>.</p> <p>b. Explain how constraints and consequences impact scientific inquiry and <i>technological design</i>.</p>	<p>Students explain how the relationship between scientific inquiry and <i>technological design</i> influences the advancement of ideas, products, and <i>systems</i>.</p> <p>a. Provide an example that shows how science advances with the introduction of new technologies and how solving technological problems often impacts new scientific knowledge.</p> <p>b. Provide examples of how creativity, imagination, and a good knowledge base are required to advance scientific ideas and <i>technological design</i>.</p> <p>c. Provide examples that illustrate how technological solutions to problems sometimes lead to new problems or new fields of inquiry.</p>

C3 Science, Technology, and Society

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
<p>No performance indicator.</p> <p>Although no performance indicators are stated, students are expected to have instructional experiences that describe influences of science and technology on their own lives.</p>	<p>Students identify and describe the influences of science and technology on people and the environment.</p> <ul style="list-style-type: none"> a. Explain how scientific and technological information can help people make safe and healthy decisions. b. Give examples of changes in the environment caused by natural or man-made influences. c. Explain that natural resources are limited, and that reusing, recycling, and reducing materials and using renewable resources is important. 	<p>Students identify and describe the role of science and technology in addressing personal and societal challenges.</p> <ul style="list-style-type: none"> a. Describe how science and technology can help address societal challenges related to population, natural hazards, sustainability, personal health and safety, and environmental quality. b. Identify personal choices that can either positively or negatively impact society including population, ecosystem sustainability, personal health, and environmental quality. c. Identify factors that influence the development and use of science and technology. 	<p>Students describe the role of science and technology in creating and solving contemporary issues and challenges.</p> <ul style="list-style-type: none"> a. Explain how science and technology influence the <i>carrying capacity</i> and sustainability of the planet. b. Explain how ethical, societal, political, economic, and cultural factors influence personal health, safety, and the quality of the environment. c. Explain how ethical, societal, political, economic, religious, and cultural factors influence the development and use of science and technology.

C4 History and Nature of Science

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
<p>No performance indicator.</p> <p>Although no performance indicators are stated, students are expected to have instructional experiences that</p>	<p>No performance indicator.</p> <p>Although no performance indicators are stated, students are expected to have instructional experiences that</p>	<p>Students describe historical examples that illustrate how science advances knowledge through the scientists involved and through the ways scientists think</p>	<p>Students describe the human dimensions and traditions of science, the nature of scientific knowledge, and historical episodes in science that impacted science</p>

LEARNING RESULTS: PARAMETERS FOR ESSENTIAL INSTRUCTION

2007

Highlighted = Maine Department of Education Regulation 131

Words in *blue italics* are defined in the glossary.

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
describe how people use science in their lives.	describe how science helps people understand the natural world.	about their work and the work of others. <ol style="list-style-type: none"> Describe how women and men of various backgrounds, working in teams or alone and communicating about their ideas extensively with others, engage in science, engineering, and related fields. Describe a breakthrough from the history of science that contributes to our current understanding of science. Describe and provide examples that illustrate that science is a human endeavor that generates explanations based on verifiable evidence that are subject to change when new evidence does not match existing explanations. 	and society. <ol style="list-style-type: none"> Describe and provide examples of the ethical traditions in science including peer review, truthful reporting, and making results public. Select and describe one of the major episodes in the history of science including how the scientific knowledge changed over time and any important effects on science and society. Give examples that show how societal, cultural, and personal beliefs and ways of viewing the world can bias scientists. Provide examples of criteria that distinguish scientific explanations from pseudoscientific ones.

D. The Physical Setting: Students understand the universal nature of matter, energy, force, and motion and identify how these relationships are exhibited in Earth Systems, in the solar system, and throughout the universe.

D1 Universe and Solar System

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
Students describe the movement of objects across the sky, as seen	Students describe the positions and apparent motions of different	Students explain the movements and describe the location,	Students explain the physical formation and changing nature of

LEARNING RESULTS: PARAMETERS FOR ESSENTIAL INSTRUCTION

2007

Highlighted = Maine Department of Education Regulation 131

Words in *blue italics* are defined in the glossary.

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
<p>from Earth.</p> <p>a. Describe how the sun and moon seem to move across the sky.</p> <p>b. Describe the changes in the appearance of the moon from day to day.</p>	<p>objects in and beyond our solar system and how these objects can be viewed from Earth.</p> <p>a. Show the locations of the sun, Earth, moon, and planets and their orbits.</p> <p>b. Observe and report on observations that the sun appears to move across the sky in the same way every day, but its path changes slowly over the seasons.</p> <p>c. Recognize that the sun is a star and is similar to other stars in the universe.</p>	<p>composition, and characteristics of our solar system and universe, including planets, the sun, and galaxies.</p> <p>a. Describe the different kinds of objects in the solar system including planets, sun, moons, asteroids, and comets.</p> <p>b. Explain the motions that cause days, years, phases of the moon, and eclipses.</p> <p>c. Describe the location of our solar system in its galaxy and explain that other galaxies exist and that they include stars and planets.</p>	<p>our universe and solar system, and how our past and present knowledge of the universe and solar system developed.</p> <p>a. Explain why the unit of light years can be used to describe distances to objects in the universe and use light years to describe distances.</p> <p>b. Explain the role of gravity in forming and maintaining planets, stars, and the solar system.</p> <p>c. Outline the age, origin, and process of formation of the universe as currently understood by science.</p> <p>d. Describe the major events that have led to our current understanding of the universe and the current technologies used to further our understanding.</p>

D2 Earth

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
<p>Students describe Earth's weather and surface materials and the different ways they change.</p> <p>a. Explain that the sun warms the air,</p>	<p>Students describe the properties of Earth's surface materials, the processes that change them, and cycles that affect the Earth.</p>	<p>Students describe the various cycles, physical and biological forces and processes, position in space, energy transformations, and human actions that affect the short-</p>	<p>Students describe and analyze the biological, physical, energy, and human influences that shape and alter Earth Systems.</p>

LEARNING RESULTS: PARAMETERS FOR ESSENTIAL INSTRUCTION

2007

Highlighted = Maine Department of Education Regulation 131

Words in *blue italics* are defined in the glossary.

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
<p>water, and land.</p> <p>b. Describe the way in which weather changes over months.</p> <p>c. Describe what happens to water left in an open container as compared to water left in a closed container.</p>	<p>a. Explain the effects of the rotation of Earth on the day/night cycle, and how that cycle affects local temperature.</p> <p>b. Describe the various forms water takes in the air and how that relates to weather.</p> <p>c. Explain how wind, waves, water, and ice reshape the surface of Earth.</p> <p>d. Describe the kinds of materials that form rocks and soil.</p> <p>e. Recognize that the sun is the source of Earth's surface heat and light energy.</p> <p>f. Explain how the substance called air surrounds things, takes up space, and its movement can be felt as wind.</p>	<p>term and long-term changes to the Earth.</p> <p>a. Explain how the tilt of Earth's rotational axis relative to the plane of its yearly orbit around the sun affects the day length and sunlight intensity to cause seasons.</p> <p>b. Describe Earth Systems - biosphere, atmosphere, hydrosphere and lithosphere - and cycles and interactions within them (including water moving among and between them, rocks forming and transforming, and weather formation).</p> <p>c. Give several reasons why the climate is different in different regions of the Earth.</p> <p>d. Describe significant Earth resources and how their limited supply affects how they are used.</p> <p>e. Describe the effect of gravity on objects on Earth.</p> <p>f. Give examples of abrupt changes and slow changes in Earth Systems.</p>	<p>a. Describe and analyze the effect of solar radiation, ocean currents, and atmospheric conditions on the Earth's surface and the habitability of Earth.</p> <p>b. Describe Earth's internal energy sources and their role in plate tectonics.</p> <p>c. Describe and analyze the effects of biological and geophysical influences on the origin and changing nature of Earth Systems.</p> <p>d. Describe and analyze the effects of human influences on Earth Systems.</p>

D3 Matter and Energy**Performance Indicators & Descriptors**

Pre-K-2	3-5	6-8	9-Diploma
<p>Students use observable characteristics to describe objects and materials and changes to physical properties of materials.</p> <p>a. Describe objects in terms of what they are made of and their physical properties.</p> <p>b. Describe changes in properties of materials when mixed, heated, frozen, or cut.</p>	<p>Students describe properties of objects and materials before and after they undergo a change or interaction.</p> <p>a. Describe how the weight of an object compares to the sum of the weight of its parts.</p> <p>b. Illustrate how many different substances can be made from a small number of basic ingredients.</p> <p>c. Describe properties of original materials, and the new material(s) formed, to demonstrate that a change has occurred.</p> <p>d. Describe what happens to the temperatures of objects when a warmer object is near a cooler object.</p> <p>e. Describe how the heating and cooling of water and other materials can change the properties of the materials.</p> <p>f. Explain that the properties of a material may change but the total amount of material remains the same.</p> <p>g. Explain that materials can be composed of parts too small to be</p>	<p>Students describe physical and chemical properties of matter, interactions and changes in matter, and transfer of energy through matter.</p> <p>a. Describe that all matter is made up of atoms and distinguish between/among elements, atoms, and molecules.</p> <p>b. Describe how physical characteristics of elements and types of reactions they undergo have been used to create the Periodic Table.</p> <p>c. Describe the difference between physical and chemical change.</p> <p>d. Explain the relationship of the motion of atoms and molecules to the states of matter for gases, liquids, and solids.</p> <p>e. Explain how atoms are packed together in arrangements that compose all substances including elements, compounds, mixtures, and solutions.</p> <p>f. Explain and apply the understanding that substances have characteristic properties,</p>	<p>Students describe the structure, behavior, and interactions of matter at the atomic level and the relationship between matter and energy.</p> <p>a. Describe the structure of atoms in terms of neutrons, protons, and electrons and the role of the atomic structure in determining chemical properties.</p> <p>b. Describe how the number and arrangement of atoms in a molecule determine a molecule's properties, including the types of bonds it makes with other molecules and its mass, and apply this to predictions about chemical reactions.</p> <p>c. Explain the essential roles of carbon and water in life processes.</p> <p>d. Describe how light is emitted and absorbed by atoms' changing energy levels, and how the results can be used to identify a substance.</p> <p>e. Describe factors that affect the rate of chemical reactions</p>

LEARNING RESULTS: PARAMETERS FOR ESSENTIAL INSTRUCTION

2007

Highlighted = Maine Department of Education Regulation 131

Words in *blue italics* are defined in the glossary.

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
	seen without magnification.	<p>including density, boiling point, and solubility and these properties are not dependent on the amount of matter present.</p> <p>g. Use the idea of atoms to explain the conservation of matter.</p> <p>h. Describe several different types of energy forms including heat energy, chemical energy, and mechanical energy.</p> <p>i. Use examples of energy transformations from one form to another to explain that energy cannot be created or destroyed.</p> <p>j. Describe how <i>heat</i> is transferred from one object to another by conduction, convection, and/or radiation.</p> <p>k. Describe the properties of solar radiation and its interaction with objects on Earth.</p>	<p>(including concentration, pressure, temperature, and the presence of molecules that encourage interaction with other molecules).</p> <p>f. Apply an understanding of the factors that affect the rate of chemical reaction to predictions about the rate of chemical reactions.</p> <p>g. Describe nuclear reactions, including fusion and fission, and the energy they release.</p> <p>h. Describe radioactive decay and half-life.</p> <p>i. Explain the relationship between kinetic and potential energy and apply the knowledge to solve problems.</p> <p>j. Describe how in energy transformations the total amount of energy remains the same, but because of inefficiencies (<i>heat</i>, sound, and vibration) useful energy is often lost through radiation or conduction.</p> <p>k. Apply an understanding of energy transformations to solve problems.</p> <p>l. Describe the relationship among <i>heat</i>, <i>temperature</i>, and pressure in terms of the actions of atoms,</p>

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
			molecules, and ions.

D4 Force and Motion

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
<p>Students describe how objects move in different ways.</p> <p>a. Describe different ways things move and what it takes to start objects moving, keep objects moving, or stop objects.</p> <p>b. Give examples of things that make sound by vibrating.</p>	<p>Students summarize how various forces affect the motion of objects.</p> <p>a. Predict the effect of a given force on the motion of an object.</p> <p>b. Describe how fast things move by how long it takes them to go a certain distance.</p> <p>c. Describe the path of an object.</p> <p>d. Give examples of how gravity, magnets, and electrically charged materials push and pull objects.</p>	<p>Students describe the force of gravity, the motion of objects, the properties of waves, and the wavelike property of energy in light waves.</p> <p>a. Describe the similarities and differences in the motion of sound vibrations, earthquakes, and light waves.</p> <p>b. Explain the relationship among visible light, the electromagnetic spectrum, and sight.</p> <p>c. Describe and apply an understanding of how the gravitational force between any two objects would change if their mass or the distance between them changed.</p> <p>d. Describe and apply an understanding of how electric currents and magnets can exert force on each other.</p> <p>e. Describe and apply an understanding of the effects of</p>	<p>Students understand that the laws of force and motion are the same across the universe.</p> <p>a. Describe the contribution of Newton to our understanding of force and motion, and give examples of and apply Newton's three laws of motion and his theory of gravitation.</p> <p>b. Explain and apply the ideas of relative motion and frame of reference.</p> <p>c. Describe the relationship between electric and magnetic fields and forces, and give examples of how this relationship is used in modern technologies.</p> <p>d. Describe and apply characteristics of waves including wavelength, frequency, and amplitude.</p> <p>e. Describe and apply an understanding of how waves interact with other waves and with materials including reflection,</p>

LEARNING RESULTS: PARAMETERS FOR ESSENTIAL INSTRUCTION

2007

Highlighted = Maine Department of Education Regulation 131Words in *blue italics* are defined in the glossary.

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
		multiple forces on an object, and how unbalanced forces will cause changes in the speed or direction.	refraction, and absorption. f. Describe kinetic energy (the energy of motion), potential energy (dependent on relative position), and energy contained by a field (including electromagnetic waves) and apply these understandings to energy problems.

E. The Living Environment: Students understand that cells are the basic unit of life, that all life as we know it has evolved through genetic transfer and natural selection to create a great diversity of organisms, and that these organisms create interdependent webs through which matter and energy flow. Students understand similarities and differences between humans and other organisms and the interconnections of these interdependent webs.

E1 Biodiversity

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
Students describe similarities and differences in the observable behaviors, features, and needs of plants and animals. a. Describe similarities and differences in the way plants and animals look and the things that they do. b. Describe some features of plants and animals that help them live in different environments. c. Describe how organisms change	Students compare living things based on their behaviors, external features, and environmental needs. a. Describe how living things can be sorted in many ways, depending on which features or behaviors are used to sort them, and apply this understanding to sort living things. b. Describe the changes in external features and behaviors of an organism during its life cycle.	Students differentiate among organisms based on biological characteristics and identify patterns of similarity. a. Compare physical characteristics that differentiate organisms into groups (including plants that use sunlight to make their own food, animals that consume energy-rich food, and organisms that cannot easily be classified as either). b. Explain how biologists use internal	Students describe and analyze the evidence for relatedness among and within diverse populations of organisms and the importance of biodiversity. a. Explain how the variation in structure and behavior of a population of organisms may influence the likelihood that some members of the species will have adaptations that allow them to survive in a changing

LEARNING RESULTS: PARAMETERS FOR ESSENTIAL INSTRUCTION

2007

Highlighted = Maine Department of Education Regulation 131

Words in *blue italics* are defined in the glossary.

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
during their lifetime.		<p>and external anatomical features to determine relatedness among organisms and to form the basis for classification <i>systems</i>.</p> <p>c. Explain ways to determine whether organisms are the same species.</p> <p>d. Describe how external and internal structures of animals and plants contribute to the variety of ways organisms are able to find food and reproduce.</p>	<p>environment.</p> <p>b. Describe the role of DNA sequences in determining the degree of kinship among organisms and the identification of species.</p> <p>c. Analyze the relatedness among organisms using structural and molecular evidence.</p> <p>d. Analyze the effects of changes in biodiversity and predict possible consequences.</p>

E2 Ecosystems

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
<p>Students understand how plants and animals depend on each other and the environment in which they live.</p> <p>a. Explain that animals use plants and other animals for food, shelter, and nesting.</p> <p>b. Compare different animals and plants that live in different environments of the world.</p>	<p>Students describe ways organisms depend upon, interact within, and change the living and non-living environment as well as ways the environment affects organisms.</p> <p>a. Explain how changes in an organism's habitat can influence its survival.</p> <p>b. Describe that organisms all over the Earth are living, dying, and decaying and new organisms are being produced by the old ones.</p>	<p>Students examine how the characteristics of the physical, non-living (abiotic) environment, the types and behaviors of living (biotic) organisms, and the flow of matter and energy affect organisms and the ecosystem of which they are part.</p> <p>a. List various kinds of resources within different biomes for which organisms compete.</p> <p>b. Describe ways in which two types of organisms may interact</p>	<p>Students describe and analyze the interactions, cycles, and factors that affect short-term and long-term ecosystem stability and change.</p> <p>a. Explain why ecosystems can be reasonably stable over hundreds or thousands of years, even though populations may fluctuate.</p> <p>b. Describe dynamic equilibrium in ecosystems and factors that can, in the long run, lead to change in the normal pattern of cyclic</p>

LEARNING RESULTS: PARAMETERS FOR ESSENTIAL INSTRUCTION

2007

Highlighted = Maine Department of Education Regulation 131

Words in *blue italics* are defined in the glossary.

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
	<ul style="list-style-type: none"> c. Describe some of the ways in which organisms depend on one another, including animals carrying pollen and dispersing seeds. d. Explain how the food of most animals can be traced back to plants and how animals use food for energy and repair. e. Explain how organisms can affect the environment in different ways. 	<p>(including competition, predator/prey, producer/consumer/decomposer, parasitism, and mutualism) and describe the positive and negative consequences of such interactions.</p> <ul style="list-style-type: none"> c. Describe the source and flow of energy in the two major food webs, terrestrial and marine. d. Describe how matter and energy change from one form to another in living things and in the physical environment. e. Explain that the total amount of matter in the environment stays the same even as its form and location change. 	<p>fluctuations and apply that knowledge to actual situations.</p> <ul style="list-style-type: none"> c. Explain the concept of <i>carrying capacity</i> and list factors that determine the amount of life that any environment can support. d. Describe the critical role of photosynthesis and how energy and the chemical elements that make up molecules are transformed in ecosystems and obey basic conservation laws.

E3 Cells

Performance Indicators & Descriptors

Pre-K-2	3-5	6-8	9-Diploma
<p>Students describe parts and wholes of living things, their basic needs, and the structures and processes that help them stay alive.</p> <ul style="list-style-type: none"> a. List living things and their parts. b. Explain that parts of living are so small we can only see them using magnifiers. c. List the basic things that most organisms need to survive. d. Identify structures that help organisms do things to stay alive. 	<p>Students describe how living things are made up of one or more cells and the ways cells help organisms meet their basic needs.</p> <ul style="list-style-type: none"> a. Give examples of organisms that consist of a single cell and organisms that are made of a collection of cells. b. Compare how needs of living things are met in single-celled and multi-celled organisms. 	<p>Students describe the hierarchy of organization and function in organisms, and the similarities and differences in structure, function, and needs among and within organisms.</p> <ul style="list-style-type: none"> a. Describe the basic functions of organisms carried out within cells including the extracting of energy from food and the elimination of wastes. b. Explain the relationship among cells, tissues, organs, and organ <i>systems</i>, including how tissues and organs serve the needs of cells and organisms. c. Compare the structures, <i>systems</i>, and interactions that allow single-celled organisms and multi-celled plants and animals, including humans, to defend themselves, acquire and use energy, self-regulate, reproduce, and coordinate movement. d. Explain that all living things are composed of cells numbering from just one to millions. 	<p>Students describe structure and function of cells at the intracellular and molecular level including differentiation to form <i>systems</i>, interactions between cells and their environment, and the impact of cellular processes and changes on individuals.</p> <ul style="list-style-type: none"> a. Describe the similarities and differences in the basic functions of cell membranes and of the specialized parts within cells that allow them to transport materials, capture and release energy, build proteins, dispose of waste, communicate, and move. b. Describe the relationship among DNA, protein molecules, and amino acids in carrying out the work of cells and how this is similar among all organisms. c. Describe the interactions that lead to cell growth and division (mitosis) and allow new cells to carry the same information as the original cell (meiosis). d. Describe ways in which cells can malfunction and put an organism

LEARNING RESULTS: PARAMETERS FOR ESSENTIAL INSTRUCTION

2007

Highlighted = Maine Department of Education Regulation 131Words in *blue italics* are defined in the glossary.

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
			<p>at risk.</p> <p>e. Describe the role of regulation and the processes that maintain an internal environment amidst changes in the external environment.</p> <p>f. Describe the process of metabolism that allows a few key biomolecules to provide cells with necessary materials to perform their functions.</p> <p>g. Describe how cells differentiate to form specialized <i>systems</i> for carrying out life functions.</p>

E4 Heredity and Reproduction

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
<p>Students describe the cycle of birth, development, and death in different organisms and the ways in which organisms resemble their parents.</p> <p>a. Give examples of how organisms are like their parents and not like them.</p> <p>b. Describe the life cycle of a plant or animal (including being born,</p>	<p>Students describe characteristics of organisms, and the reasons why organisms differ from or are similar to their parents.</p> <p>a. Name some likenesses between children and parents that are inherited, and some that are not.</p> <p>b. Explain that in order for offspring to look like their parents, information related to inherited</p>	<p>Students describe the general characteristics and mechanisms of reproduction and heredity in organisms, including humans, and ways in which organisms are affected by their genetic traits.</p> <p>a. Explain that sexual reproduction includes fertilization that results in the inclusion of genetic information from each parent and</p>	<p>Students examine the role of DNA in transferring traits from generation to generation, in differentiating cells, and in evolving new species.</p> <p>a. Explain some of the effects of the sorting and recombination of genes in sexual reproduction.</p> <p>b. Describe genes as segments of DNA that contain instructions for</p>

LEARNING RESULTS: PARAMETERS FOR ESSENTIAL INSTRUCTION

2007

Highlighted = Maine Department of Education Regulation 131

Words in *blue italics* are defined in the glossary.

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
growing, reproducing, and dying).	likenesses must be handed from parents to offspring in a reliable manner.	<p>determines the inherited traits that are a part of every cell.</p> <p>b. Identify some of the risks to the healthy development of an embryo including mother's diet, lifestyle, and hygiene.</p> <p>c. Describe asexual reproduction as a process by which all genetic information comes from one parent and determines the inherited traits that are a part of every cell.</p>	<p>the cells and include information that leads to the differentiation of cells.</p> <p>c. Explain how the instructions in DNA that lead to cell differentiation result in varied cell functions in the organism and DNA.</p> <p>d. Describe the possible causes and effects of gene mutations.</p>

E5 Evolution

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
<p>Students describe similarities and differences between present day and past organisms that helped the organisms live in their environment.</p> <p>a. Describe some organisms' features that allow the organisms to live in places others cannot.</p> <p>b. Explain how some kinds of organisms that once lived on Earth have completely disappeared, although they were similar to some that are alive today.</p>	<p>Students describe the fossil evidence and present explanations that help us understand why there are differences among and between present and past organisms.</p> <p>a. Explain advantages and disadvantages gained when some individuals of the same kind are different in their characteristics and behavior.</p> <p>b. Compare fossils to one another and to living organisms according</p>	<p>Students describe the evidence that evolution occurs over many generations, allowing species to acquire many of their unique characteristics or adaptations.</p> <p>a. Explain how the layers of sedimentary rock and their contained fossils provide evidence for the long history of Earth and for the long history of changing life.</p> <p>b. Describe how small differences between parents and offspring can</p>	<p>Students describe the interactions between and among species, populations, and environments that lead to natural selection and evolution.</p> <p>a. Describe the premise of biological evolution, citing evidence from the fossil record and evidence based on the observation of similarities within the diversity of existing organisms.</p> <p>b. Describe the origins of life and how the concept of natural</p>

LEARNING RESULTS: PARAMETERS FOR ESSENTIAL INSTRUCTION

2007

Highlighted = Maine Department of Education Regulation 131Words in *blue italics* are defined in the glossary.

Performance Indicators & Descriptors			
Pre-K-2	3-5	6-8	9-Diploma
	to their similarities and differences.	<p>lead to descendants who are very different from their ancestors.</p> <p>c. Describe how variations in the behavior and traits of an offspring may permit some of them to survive a changing environment.</p> <p>d. Explain that new varieties of cultivated plants and domestic animals can be developed through genetic modification and describe the impacts of the new varieties of plants and animals.</p>	<p>selection provides a mechanism for evolution that can be advantageous or disadvantageous to the next generation.</p> <p>c. Explain why some organisms may have characteristics that have no apparent survival or reproduction advantage.</p> <p>d. Relate structural and behavioral adaptations of an organism to its survival in the environment.</p>